"Historical and other Studies of Science, Technology and Medicine in the University of Edinburgh"

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Considering Edinburgh's prominence in the historical development of the sciences, it might be expected that the formal study of the history of science would appear as a significant feature in its University. Alas, this is not so; although there are signs that things are beginning to improve. If there is a deficit in historical studies of science, however, it is surely outweighed by Edinburgh's remarkable contribution to the sociological study of science and technology, which has even given rise to the designation "Edinburgh School" to refer to a characteristic approach to the study of science which was developed in Edinburgh University. In what follows, we will briefly consider the history of these and other aspects of the study of science, technology and medicine in Edinburgh as well as presenting an outline of the current picture.

History of Science in Edinburgh University

The formal representation of the history of science at the University began in 1965 with the appointment of Eric Forbes (1933-1984) in the Department of History. Trained as an astronomer in St Andrews (his home town), Forbes subsequently studied first for the MSc and then a PhD in history of science at University College, London. He took up the post in Edinburgh after completing the MSc in 1965.[1] The history of science, perhaps as a result of its comparative smallness, has always been a sub-discipline played out on an international stage, and Forbes soon acquired an

international reputation even though he seems to have been regarded as something of an outsider within his own department. Forbes was the chief local organiser of the XVth International Congress of the History of Science, which was held in Edinburgh in 1977 and was a huge success.[2] He was awarded a personal chair in 1978, and subsequently became the Director of the first Wellcome Unit for the History of Medicine in Scotland, although he saw to it that it was designated the History of Medicine and Science Unit.

It might have seemed at this point that the future of the history of science and medicine in Edinburgh was secure. It was far from it. After Professor Forbes's death in 1984 there was nobody in the University who could take over as Director of the Wellcome Unit. The active members of the Unit were all on temporary contracts, and there was nobody else who was seen to have an interest in the history of medicine. Nowadays, any University Department in danger of losing a Unit funded by the Wellcome Trust would simply appoint somebody to fit the bill, but these were the days before academics in the humanities were made to care about sources of external funding. Professor Forbes's colleagues in the History Department somehow failed to recognise the importance of science in Western culture, and if his post was filled with a junior appointment it must have been in an area they deemed to be more significant—the history of the Australian penal colony, perhaps? To be fair to them, I suppose they were concerned to ensure that they could cover teaching to their history students, but Eric Forbes had almost exclusively taught ancillary courses to undergraduates in the Science Faculty. The Wellcome Unit moved to the University of Glasgow, where Professor David Hamilton, a professor of surgery who had published a fine history of medicine in Scotland in 1981, became its Director.[3] The

support of this Unit recently passed from the Wellcome Trust to the Unversity of Glasgow, and the Centre for the History of Medicine is now part of its Department of Economic and Social History. It is perhaps worth mentioning that one of the Centre's most distinguished and long-standing researchers, and teachers, Dr Malcolm Nicolson, began his career in the Edinburgh Wellcome Unit under Professor Forbes.[4]

Professor Forbes's contributions to scholarship did not end with his death. Indeed, arguably the most important aspect of his legacy as a scholar has only recently achieved completion. This is the edition of the correspondence of the first Astronomer Royal, John Flamsteed, which he had begun, but which had to be seen through the press by his wife, Maria, who enlisted the help of Lesley Murdin and Frances Willmoth.[5] Nevertheless, with his death, the formal representation of the history of science at the University might have ended, if it had not been for the intervention of the group of scholars working in the Faculty of Science, as the Science Studies Unit.

The Science Studies Unit was established in 1966 as part of an initiative instigated by the renowned evolutionary biologist and geneticist, C. H. Waddington (1905-1975), to diminish from the science side, the separation between the "Two Cultures" (of the arts and the sciences), which had recently been highlighted by the novelist and prominent intellectual, C. P. Snow.[6] The man charged with setting up the Unit was David Edge (1932-2003), who had trained as a radio astronomer under Martin Ryle at the Cavendish Laboratory, but who was then working for the Science Unit at the BBC. David brought together Barry Barnes, a molecular biologist turned sociologist of science, David Bloor, an experimental psychologist, and Gary Werskey, a radical socialist historian of science, who was later replaced by Steven Shapin, whose

doctoral dissertation, at the University of Pennsylvania (1971), had focussed on the Royal Society of Edinburgh.

Being part of the Science Faculty, and teaching science undergraduates, the members of the Science Studies Unit noticed the loss to science students of Eric Forbes's courses in the history of science more than anyone in the History Department could have done. Accordingly, they tried to ensure that he was replaced by another historian of science. This is how I first came to Edinburgh in 1986, a historian of science trained at the University of Leeds and the Open University, just then working at the Wellcome Institute for the History of Medicine in London. I arrived shortly after the publication by Steven Shapin (with the collaboration of Simon Schaffer of the History and Philosophy of Science Department in Cambridge) of *Leviathan and the Air-pump*, a much feted and highly influential study of the categorically different approaches to scientific practice and scientific knowledge of Thomas Hobbes and Robert Boyle.[7] As I am also a seventeenth-century specialist, I felt that, with Shapin as a colleague, I was coming to a significant centre for the history of early modern science, but after the departure of Steven Shapin to the University of California, San Diego, in 1989 (he has since moved again—to Harvard University), I began to realise that I was then, like Eric Forbes before me, the only historian of science in the University.

Fortunately, the situation has now changed. With the benefit of Wellcome Trust funding the Science Studies Unit subsequently appointed Dr Steve Sturdy, who had produced a much admired doctoral dissertation on John Scott Haldane at the Unit in 1987, and who was then working at the Wellcome Unit for the History of Medicine in the University of Manchester.[8] More recently we have appointed Dr Ivan Crozier,

who is a historian of psychology and forensic psychiatry.[9] Currently we also have two historians on temporary contracts: Emese Lafferton, a historian of psychology from Hungary, who was previously working at Cambridge, and Lawrence Dritsas, a post-doctoral research fellow, whose doctoral dissertation (undertaken in Edinburgh's Centre of African Studies) on the scientific aspects of Livingstone's Zambesi expedition (1858-1864) is about to appear as a book.[10] Furthermore, even David Bloor, one of the architects of the distinctive Edinburgh style of the sociology of scientific knowledge (about which more in a moment), has now switched from using the previous work of historians as case studies for his own theoretical arguments in the sociology of knowledge, to doing his own historical research. Professor Bloor is just completing a major historical study of the theory of the aerofoil (from 1904 to 1926), and now that he has just retired, intends to turn next to the history of experimental psychology.

This increased focus on history is currently having repercussions also for our student intake. Although our undergraduate teaching remains entirely "service" teaching, mostly to science and engineering students who cannot pursue the history of science or medicine beyond their second year, even if they wanted to, we are increasingly able to offer history courses to our MSc students, and so may soon be able to recruit students to a Master's degree which is predominantly in the history, rather than the sociology of science.

Furthermore, even the School of History, Classics and Archaeology (which now includes the old History Department and the Department of Economic and Social History, among others), has begun to recognise the importance of the history of

science and medicine. Professor Roger Davidson has developed, since the 1990s, a new interest in the history of sexuality and of venereal diseases in the twentieth century, and he continues to publish prolifically.[11] Meanwhile, Gayle Davis, a former doctoral student and now collaborator of his, and current holder of a Wellcome Trust University Award, is developing her interests in the history of sexuality and psychiatry, and reproductive health.[12] Thomas Ahnert, a recent appointment in history, is chiefly interested in religion in the Enlightenment but has also worked on the spread of Newtonianism in eighteenth-century Germany;[13] while another recent appointment, Monica Azzolini, who wrote her doctoral dissertation on Leonardo da Vinci and medicine, has wider interests in the history of science in the Renaissance.[14] It seems that the School of History has finally recognised the importance of the history of science and medicine. Indeed, I have been invited to contribute courses on the history of science to two new MSc degrees offered by the School of History, one on Enlightenment Studies and the other on Intellectual History. Similarly, my colleague, Ivan Crozier has been asked to offer a course on the history of psychology to a new MSc programme in the Psychology Department.

There are other out-posts of history of science elsewhere in the University. Although Charles Withers is Professor of Historical Geography in our School of Geosciences, much of his work on geographies of knowledge is concerned not only with knowledge of geography, but also with scientific knowledge in general.[15] Similarly, Professor Francesca Bray, who has recently moved from the University of California, Santa Barbara, to our Department of Social Anthropology, is well-known for her work on the history of technology in China.[16]

The Sociology of Science in Edinburgh University

The origins of the study of the sociology of science at Edinburgh can be traced back to the Science Studies Unit which, as we have already noted, was established in the late 1960s under the extremely energetic Directorship of David Edge. Dr Edge published his own significant contribution to the social study of science in his *Astronomy Transformed* of 1976 (written in collaboration with Michael Mulkay), and other works.[17] But perhaps his most influential contribution to the field was his editorship of the journal, *Social Studies of Science*, which he founded with Roy McLeod (then at the Science Policy Research Unit in the University of Sussex). Founded in 1971, this journal helped to shape the field of the social studies of science as it began to flourish in the seventies, and it continued to be edited by Dr Edge until 2002. As if this wasn't significant enough, he also helped to shape the field by the appointments he made to his incipient Unit. Edge is reported as saying that when C. H. Waddington gave him the role of setting up the Unit Waddington said to him: "We'll teach 'em the science—you teach 'em the rest."[18] Given the vagueness of the brief, it is remarkable that what emerged, largely as a result of the highly fruitful collaboration of Barry Barnes and David Bloor, was so distinctive. Both were highly influenced by the work of Thomas Kuhn, author of the influential *Structure of Scientific Revolutions* (1962), and as a result they kept a close eye on contemporary publications in the history of science, which they saw as extending Kuhn's approach by trying to understand the development of science, the "logic of scientific discovery" if you will, not in terms of theories in the philosophy of science, but by close scrutiny of what actually took place, and trying to understand what took place in historical terms.[19] Neither Barnes nor Bloor showed any inclination to pursue their own

historical studies, but they were always careful to use the best historical case studies to support their theoretical claims about the way science developed.[20] Furthermore, under the influence of the rich fabric of historical case studies, they developed a sociological, rather than a philosophical account, of the development of scientific knowledge. Turning then to the sociology of knowledge as it had been developed by the founding fathers of sociology, Barnes and Bloor quickly noticed that thinkers like Karl Mannheim and others had deliberately excluded science from their sociologies of knowledge. Mannheim, writing as any positivist might have done, declaimed that, although we might need a sociological account to explain why we believe, say, a religious proposition, we do not need a sociological account to explain why we believe scientific propositions, because scientific knowledge is true. We believe in the circulation of the blood, Mannheim might have said, because the blood circulates. Familiarity with the history of science, and with the all too obvious fact that scientific knowledge was changing apace in the late 1960s, led Barnes and Bloor to reject Mannheim's position and to insist that we should continue to ask ourselves why we believe scientific claims.[21] Part of the answer to that question, they believed, would always reside in sociological factors. We cannot say we believe in the curvature of space, for example, simply because space curves. To fully understand this claim we have to take into account, for example, the fact that scientists in the nineteenth century rejected the possibility of action at a distance, even though Newton, and many eighteenth-century Newtonians had been perfectly happy to accept and rely upon this notion.[22] The rejection of action at a distance did not arise from the fact that there was no evidence for it, much less that there was direct evidence against it, but having made that rejection, the phenomenon of gravitational attraction had to be explained away—and curved space offered a useful escape. Barnes's and Bloor's strong line on

the sociology of knowledge gave rise to the designation "strong programme", and was justified in terms of a "symmetry principle", meaning that scientific knowledge should be treated symmetrically with other kinds of knowledge claim. If we believe that we need to look to social factors to understand why the Azande believe in the "chicken oracle", then we also need to look to social factors to understand why Western physicists believe in the curvature of space.[23] Unfortunately, many critics of what soon became known as the "Edinburgh School" mistakenly took their symmetry principle to mean that the chicken oracle and the curvature of space (to remain with the same examples) should be regarded as both equally true (or both equally false). This is not the place to enter into a defence of the strong programme, but suffice it to say that this bad, and sad, misreading shows a lamentable lack of careful thought by the critics of the strong programme.[24]

Barnes and Bloor produced a number of books and a great many papers between them and continue to do so, although Barnes moved to the Department of Sociology in the University of Exeter in 1992.[25] The Unit has also attracted a number of highly successful doctoral candidates who have since proceeded to make distinguished academic careers. I have already mentioned Drs Malcolm Nicolson and Steve Sturdy, who have subsequently made names for themselves as leading historians of medicine. John Law, leading contributor to actor network theory, and now Professor of Sociology in the University of Lancaster began his training in science studies at Edinburgh.[26] After completing a PhD at Cambridge in materials science, Brian Wynne, trained as a sociologist of science in the Unit, and is currently Professor of Science Studies and Research Director of the Centre for the Study of Environmental Change (CSEC) at Lancaster.[27] Another product of the Unit is Professor Andrew

Pickering, of the Department of Sociology at the University of Illinois at Urbana-Champaign, who came to the Unit after completing a PhD in particle physics in London, and whose second doctoral dissertation was published as *Constructing Quarks: A Sociological History of Particle Physics*.[28] Graham Spinardi's doctoral dissertation of 1988 was published as a book in 1994 and remains in print. Dr Spinardi himself remained in Edinburgh as one of our most successful researchers, and is now a Senior Research Fellow in our Research Centre for Social Sciences (about which we will hear shortly). He is currently working on the history of post-war radar development in Britain.[29] More recently, in 1999, Matthias Klaes completed a doctoral dissertation on the conceptual history of transaction costs in economics, while Dr Massimo Mazzotti, completed a thesis on the history of mathematics in eighteenth-century Italy. The former is currently Professor of Commerce at the University of Keele;[30] and the latter lectures in the Department of Sociology and Philosophy at the University of Exeter.[31] I should also mention Martin Kusch, who was appointed as a lecturer in the Unit in 1993 after the departure of Barry Barnes, and began to extend the strong programme from scientific to philosophical knowledge, and applied the lessons of the sociology of knowledge to the understanding of psychology, before taking up a professorship in the Department of History and Philosophy of Science in Cambridge.[32]

Arguably the most successful doctoral graduate from the Unit is now one of our Professors of Sociology, Donald MacKenzie. His dissertation was published as *Statistics in Britain, 1865-1930: The Social Construction of Scientific Knowledge*, but he subsequently went on to apply the lessons of the strong programme to a number of aspects of technology, including advanced weapons systems, and computers, and

more recently to financial markets, the results of which have appeared as prize-winning books.[33]

Professor MacKenzie has also been one of the prime movers in extending the social study of science and technology beyond the comparatively narrow remit of the Unit's strong programme in the sociology of knowledge. As indeed, has Dr Wendy Faulkner, who trained at the Science and Technology Policy Research Unit (SPRU), at the University of Sussex, and came to Edinburgh in 1988. Dr Faulkner's work is much more traditionally sociological than the original autodidacts of the Unit, as can be seen, for example, in her studies of issues of gender in institutions of engineering, and more recently in studies of the politics and processes of enhancing public engagement in new or controversial areas of science and technology.[34]

The first manifestation of the expansion of the social studies of science in Edinburgh was the establishment of the Research Centre for Social Sciences (RCSS) in 1986, after a successful bid for a centre focusing on the social shaping of technology to the Economic and Social Research Council (ESRC) Programme on Information and Communication Technologies (PICT). This interdisciplinary grouping was convened by Robin Williams, formerly of the University of Aston in Birmingham, and was set up, among other things, to promote and host inter-disciplinary research on science and technology.[35] This programme of collaborative interdisciplinary research on technology continued after PICT ended and has grown substantially thanks largely to continuing success in winning external research funding. Key areas of research include information, media and communications technologies; science, technology and the environment; biotechnology; nanotechnology; military technology; risk and

public science policy; and technology transfer. Its focus has recently broadened yet again to include life science technologies, following on from a successful bid for an ERSC Centre for Socioeconomic Research on Innovation in genomics (Innogen).

Formed in October 2002, and given a further award of five million pounds in 2006, Innogen, the ESRC centre for social and economic research on innovation in genomics, is a collaboration between the University of Edinburgh and The Open University, and part of the ESRC Genomics Network studying the evolution of genomics and life sciences and their far-reaching social and economic implications (for example, the potential to transform health care and food production systems in developed and developing countries, to provide one of the main platforms of economic growth and global competitiveness in the 21st century, and to challenge our existing regulatory systems by raising new ethical and social issues). Originally under the Directorship of Professor Joyce Tait, who was awarded a CBE for services to the social sciences in 2005, it now has a new Director, David Wield, Professor of Innovation and Development, while Dr Cartherine Lyall continues to act as its Deputy Director.[36] Innogen's research is intended to provide a sound base for decision-making in science, industry, policy and public arenas and to improve our understanding of each of these groups and their interactions. Through affiliated staff members it has direct links to the Medical School's Department of Community Health Sciences, the Law School's AHRC Research Centre in Intellectual Property and Technology, and the Department of Social Anthropology. Innogen also engages with a wide range of stakeholders, nationally and internationally, including scientists, industry and private interest groups, policy makers and regulators, and citizens' and other public interest groups.

Closely associated with Innogen is the ESRC Genomics Policy and Research Forum, Directed since 2006 by Stephen Yearley. Professor Yearley (whose research interests have included environmental controversies with a pronounced scientific element, such as recent disputes over the safety or otherwise of GMOs; attempts to foster public engagement in technical decision-making in environmental areas; and social aspects of human genetics, including issues of bioethics)[37] was appointed to the Sociology Department in 2005 as Professor of the Sociology of Scientific Knowledge, thereby showing, not only the University's recognition of the liveliness and dynamism of this area of the social sciences, but also the University's commitment to it. Steve Sturdy, of the Science Studies Unit, has been seconded to the Genomics forum since 2006, as its Deputy Director.

Another successful initiative, launched in April 1989, was The Institute for Japanese-European Technology Studies. JETS is sponsored by the Japanese Ministry of International Trade and Industry, the British Department of Trade and Industry, the Lothian Regional Council, and a number of major companies including NEC and Fujitsu, and also has close links with the Japanese Science and Technology Agency and its National Institute of Science and Technology Policy, as well as with the European Commission. The major objectives of JETS are to pursue policy-oriented research on science, technology, industry, and business strategy in Japan and Europe; to encourage closer links between researchers in Japan and Europe; to develop a documentation centre on science, technology, industry, and business strategy in Japan and Europe. JETS has a Research Advisory Committee whose members include many leading academics who are well-known internationally for their research in the area of

science and technology policy. The Director, who was instrumental in the foundation of JETS, is one of our Professors of Economics, Martin Fransman, who has published widely in this area.[38]

Given this array of different centres each concerned with the social dimensions of science and technology, it was recently decided to form a virtual umbrella institute, to cover them all, known as the Institute for the Study of Science Technology and Innovation (ISSTI). Coordinated by the RCSS, under the very capable management of Professor Robin Williams, ISSTI not only embraces the Science Studies Unit, Innogen, the Genomics Forum, and JETS but also maintains links to the Entrepreneurship and Innovation group in the Management School and Economics, and to the research centre in Intellectual Property and Technology Law, in the School of Law. ISSTI also benefits from close links with the College of Science and Engineering (especially its School of Informatics), and (thanks largely to Innogen) to the College of Medicine and Veterinary Medicine.

The teaching of science studies is confined to the Science Studies Unit and RCSS. As mentioned before, undergraduate teaching is service teaching, mostly for the College (formerly, Faculty) of Science and Engineering, but there are a range of postgraduate offerings, including three MSc programmes, and a doctoral programme in science and technology studies. Many of our MSc courses continue to draw heavily on historical studies to illustrate the social and cultural dimensions of scientific and technological development.

The social study of the sciences and technology at Edinburgh University, then, has been immensely successful. Firstly, the "Edinburgh School" made a huge impact in generating academic debate, or even controversy, about the nature of scientific knowledge, and has proved to be influential not only in the sociology of science, but also in the history and philosophy of science. Subsequently the other centres, often concerned with more pragmatic aspects of science and technology in modern life, became highly successful not only in terms of their scholarly output, but also in attracting external research funding and thereby establishing a thriving research community, and ensuring the continuation of this characterising aspect of the University of Edinburgh.

Science and Religion in Edinburgh University

Edinburgh has yet another claim to the academic scrutiny of science as a phenomenon in its own right, and that is through the long-standing institution of the Gifford Lectures. Established by a bequest to the original four Scottish universities from Adam Lord Gifford (1820-1887), a senator of the College of Justice in Scotland, the lectures were intended to "promote and diffuse the study of Natural Theology in the widest sense of the term—in other words, the knowledge of God". In spite of the increasing secularization of both science and society, the lectures continue to flourish. The roster of Edinburgh Gifford lecturers includes William James, Henri Bergson, Arthur Eddington, A. N. Whitehead, Albert Schweitzer, Charles Sherrington, Neils Bohr, John Eccles, John Polkinghorne, and most recently (2007) the leading evolutionary biologist, Simon Conway Morris.[39]

The School of Divinity received an award from the Templeton Foundation some years ago which facilitated the teaching of two honours courses on the relations between science and religion. These are taught over a two-year cycle by Revd Dr Michael Fuller, who is the Ministry Development Officer for the Theological Institute of the Scottish Episcopal Church (TISEC).[40] Additionally, a few years ago a small reading group formed by those at the University who were interested in the relationship between science and religion gave rise to the formation of a new MSc course on "The History of Science and Religion in the Western Tradition". Team-taught by David Fergusson, Professor of Divinity, Wilson Poon, Professor of Physics, Michael Fuller, and myself, the course has consistently proved to be a popular option for students working towards the School of Divinity's MTh or MSc on Theology in History.[41]

From the outset, it was always our intention to develop this further into a new MTh or MSc programme on science and religion, and this is now beginning to take shape with additional help from Michael S. Northcott, Professor of ethics in the School of Divinity. Professor Northcott's book on *The Environment and Christian Ethics* (1996) is in its fourth printing, and he has published widely on issues such as bioethics, the ethics of food, and genetic modification. His latest work is a major consideration of ethical issues arising from global warming.[42]

So far, our ambitions to introduce the study of interactions between science and religion into the curriculum at Edinburgh are in the early stages. But given the undeniable cultural importance of both science and religion, the continuing well-publicised controversies in this area, and the engagement and commitment of our group, it is hoped that it may one day take its place alongside the other aspects of the

study of science as a cultural phenomenon which are already flourishing in Edinburgh.

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[1] A. J. Meadows, "Forbes, Eric Gray (1933-1984)", *Oxford Dictionary of National Biography* (Oxford: Oxford University Press, 2004).

[2] Eric G. Forbes (ed.), *Human Implications of Scientific Advance: Proceedings of the XVth International Congress of the History of Science, Edinburgh, 10-15 August 1977* (Edinburgh: Edinburgh University Press, 1978). Professor Forbes's main scholarly out-put was concerned with the German astronomer and discoverer of the libration of the Moon, Tobias Mayer (1723-1762), whom he had studied for his doctorate. See, for example, Eric G. Forbes, *The Euler-Mayer Correspondence (1751-1755): A New Perspective on Eighteenth-Century Advances in the Lunar Theory* (London: Macmillan, 1971); *Tobias Mayer, 1723-62: Pioneer of Enlightened Science in Germany* (Göttingen : Vandenhoeck und Ruprecht, 1980); *The Unpublished Writings of Tobias Mayer*, 3 vols (Göttingen : Vandenhoeck & Ruprecht, 1972)

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[4] Recent publications include: Malcolm Nicolson and George Lowis, "The Early History of the British Multiple Sclerosis Society: A Study of Lay/Practitioner Interaction in the Context of a Medical Charity", *Medical History*, 46 (2002), pp. 141-174; and Malcolm Nicolson and John Fleming, "Scottish Innovations: The Case Study of Ultrasound", in A. Patrizio and D. Kemp (eds), *Anatomy Acts: How We Come to Know Ourselves* (Edinburgh: Birlinn, 2006), pp. 51-62.

[5] Eric G. Forbes, Lesley Murdin and Frances Willmoth (eds), *The Correspondence of John Flamsteed, the First Astronomer Royal*, Vol.1, 1666-1682 (Bristol: Institute of Physics Publishing, 1995), Vol.2, 1682-1703 (Bristol: Institute of Physics Publishing, 1997), Vol. 3, 1703-1719 (Bristol: Institute of Physics Publishing, 2002). See also Eric G. Forbes (ed.), *The Gresham Lectures of John Flamsteed*

(London: Mansell, 1975); and idem, *Greenwich Observatory: The Story of Britain's Oldest Scientific Institution, the Royal Observatory at Greenwich and Herstmonceux, 1675-1975. Vol. 1, Origins and Early History, 1675-1835* (London: Taylor and Francis, 1975). See also the memorial tribute volume: Graeme Cruickshank, *A Sense of Place: Studies in Scottish Local History: A Volume of Essays Commissioned by the Scottish Local History Forum as a Tribute to the late Professor Eric Forbes* (Edinburgh : Scotland's Cultural Heritage, 1988).

[6] C. P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge: Cambridge University Press, 1959). Waddington was appointed to Edinburgh in 1947, and created there one of the largest genetics departments in the world. He also produced the influential textbook, *Principles of Embryology* (London: Allen and Unwin, 1956).

[7] Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (Princeton: Princeton University Press, 1985).

[8] See, for example, Steve Sturdy, "Biology as Social Theory: John Scott Haldane and Physiological Regulation", *British Journal for the History of Science*, 21 (1988), 315-340; "Scientific Method for Medical Practitioners: The Case Method of Teaching Pathology in Early Twentieth-Century Edinburgh", *Bulletin of the History of Medicine*, 81 (2007), 760-792; and (as editor), *Medicine, Health and the Public Sphere in Britain* (London: Routledge, 2002)

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[10] Lawrence Dritsas, "From Lake Nyassa to Philadelphia: A Geography of th eZambesi Expedition, 1858-64", BJHS, 38 (2005), pp. 35-5; and *Zambesi: David Livingstone and Expeditionary Science in Africa* (London: I. B. Tauris), forthcoming. For examples of Dr Lafferton's work, consider Emese Lafferton, "Murder by Hypnosis? Altered States and the Mental Geography of Science," in John Pickstone and Roberta Bivins (eds), *Medicine, Madness and Social History: Essays in Memory of Roy Porter* (Basingstoke: Palgrave Macmillan), forthcoming; "What the Files Reveal: The Social Make-Up

of Public Mental Asylums in Hungary, 1860s-1910s", in Heiner Fangerau and Karen Nolte (eds), *'Moderne' Anstaltspsychiatrie im 19. und 20. Jahrhundert - Legitimation und Kritik* (Stuttgart: Franz Steiner Verlag, 2006), pp. 83-103; "From Private Asylum to University Clinic: Hungarian Psychiatry, 1850-1908", in George S. Rousseau, et al. (eds), *Framing and Imagining Disease in Cultural History* (Basingstoke: Palgrave Macmillan, 2003), pp. 190-213.

[11] Recent examples include: Roger Davidson, *Dangerous Liaisons: A Social History of Venereal Disease in Twentieth Century Scotland* (Amsterdam: Rodopi, 2000); "The Sexual State: Sexuality and Scottish Governance, 1950-80", *Journal of the History of Sexuality*, 13 (2004), pp. 500-21; and "Interpreting the 'Great Scourge': Approaches to the History of Venereal Disease in Modern European Society", in A. Andresen, K. T. Elvbakken and W. H. Hubbard (eds.), *Public Health and Preventive Medicine, 1800-2000: Knowledge, Co-operation and Conflict* (Bergen: Rokken Centre, 2004).

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[13] Thomas Ahnert, "Newtonianism in early Enlightenment Germany, c.1720-1750", *Studies in the History and Philosophy of Science*, 35 (2004), pp. 471-91. See also "*De Sympathia et Antipathia Rerum*: Natural law, religion and the rejection of mechanistic science in the works of Christian Thomasius", in T. Hochstrasser and P. Schröder (eds.), *Early Modern Natural Law Theories: Strategies and Contexts in the Early Enlightenment* (Dordrecht, 2003), pp. 257-77; and "Nullius in verba: Autorität und Experiment in der Frühen Neuzeit. Das Beispiel Johann Christoph Sturms (1635-1703)", *Zeitsprünge*, 7/4 (2003), pp. 604-18.

[14] Monica Azzolini, "Reading Health in the Stars: Prognosis and Astrology in Renaissance Italy", *Horoscopes and Public Spheres: Essays on the History of Astrology*, (Berlin: Walter de Gruyter, 2005), pp. 183-205; "Leonardo da Vinci's Anatomical Studies in Milan: A Re-examination of Sites and Sources", *Visualizing Medieval Medicine and Natural History, 1200-1550* (Aldershot: Ashgate, 2006), 147 – 176; "In Praise of Art: Text and Context of Leonardo's Paragone and its Critique of the Arts and Sciences", *Renaissance Studies*, 19 (2005), pp. 487-510; and "Anatomy of a Dispute: Leonardo, Pacioli, and Scientific Entertainment in Renaissance Milan", *Early Science and Medicine*, 9 (2004), pp. 115 -135.

[15] See, for example, Charles W. J. Withers, *Geography, Science and National Identity: Scotland since 1520* (Cambridge: Cambridge University Press, 2001); *Placing the Enlightenment: Thinking Geographically About the Age of Reason* (Chicago: University of Chicago Press, 2007).

[16] Francesca Bray, *Science and Civilization in China. Vol.6, Biology and Biological Technology: Part 2, Agriculture* (Cambridge: Cambridge University Press, 1984); and *Technology and Gender: Fabrics of Power in Late Imperial China* (Berkeley: University of California press, 1997).

[17] David O. Edge and Michael J. Mulkay, *Astronomy Transformed: The Emergence of Radio Astronomy in Britain* (London: Wiley, 1976). See also, Barry Barnes and David Edge (eds), *Science in Context: Readings in the Sociology of Science* (Milton Keynes: Open University Press, 1982).

[18] Reported in David Bloor, "David Owen Edge: Obituary", *Social Studies of Science,* 33 (2003), pp. 171-6. This appeared in the special issue of the journal (33, Part 2, 2003), which was dedicated to David Edge and also included tributes from Michael Lynch (in the Editorial), Sheila Jasanoff, Roy MacLeod, Harry Collins, Geoffrey C. Bowker, Aant Elzinga, Mary Frank Fox, Bruno Latour, Trevor Pinch, Wesley Shrum and Stephen Barr.

[19] Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962). The "logic of scientific discovery" was the phrase most commonly used to define the major enterprise of the philosophy of science as it was promoted by the Vienna Circle and subsequent philosophers of science. The philosophers' general assumption was that scientific discovery could be reduced to logical rules, the application of which accounted for the success of science. The classic example of such a rule is exemplified in Karl Popper's "falsificationism". Kuhn, of course, rejected abstract philosophical approaches in favour of a historically based typology of how scientific discoveries are made and established. The literature is vast, but see, for example, Alexander Bird, *Thomas Kuhn* (Princeton: Princeton University Press, 2000); and Barry Barnes, *T. S. Kuhn and Social Science* (London: Macmillan, 1982). On Kuhn's influence in the history of science, see Robert S. Westman, "Two Cultures or One?: A Second Look at Kuhn's *The Copernican Revolution*", *Isis*, 85 (1994), pp. 79-115.

[20] The best demonstration of this in action is in Steven Shapin, "History of Science and Its Sociological Reconstructions", *History of Science*, 20 (1982), pp. 157-211.

[21] I simplify; for a fuller and more careful exposition, see David Bloor, *Knowledge and Social Imagery*, pp. 8-13.

[22] See, for example, Isaac Newton, Queries 1, 4, 18, 21, 29, and 31, in Book III of the *Opticks* (London: 1717). See also Robert E. Schofield, *Mechanism and Materialism: British Natural Philosophy in an Age of Reason* (Princeton: Princeton University Press, 1970); and Arnold Thackray, *Atoms and Powers: An Essay on Newtonian Matter-Theory and the Development of Chemistry* (Cambridge, Mass.: Harvard University Press, 1970). On the rejection of actions at a distance in the nineteenth century, see F. H. van Lunteren, "Gravitation and Nineteenth-Century Physical Worldviews", in P. B. Scheurer and G. Debrock (eds), *Newton's Scientific and Philosophical Legacy* (Dordrecht: Kluwer Academic, 1988), pp. 161-73.

[23] The classic account of the significance of the chicken oracle among the Azande can be found in Sir Edward Evans-Pritchard, *Witchcraft, Oracles and Magic among the Azande* (Oxford: Clarendon Press, 1937). On the history of ideas about the curvature of space, see, for example, Jeremy Gray, *Ideas of Space: Euclidean, non-Euclidean, and Relativistic* (Oxford: Clarendon Press, 1989).

[24] If anyone is still in doubt that this is a misreading of the symmetry principle, suppose I said "If we believe that we need to look to social factors to understand why medieval Europeans believed in the divine right of kings, then we also need to look to social factors to understand why modern Europeans believe in democracy"; nobody would leap to the conclusion that I must therefore think the divine right of kings is just as morally justifiable, or politically expedient as democracy. I would simply be making the point that we should examine them both in the same way, not decide in advance to treat one in a dismissive contemptuous fashion, and to treat the other as an unassailable moral position.

[25] Classic studies by Bloor and Barnes include: David Bloor, *Knowledge and Social Imagery*, [first published 1976] 2nd edition (Chicago: University of Chicago Press, 1991); idem, *Wittgenstein: A Social Theory of Knowledge* (London: Macmillan, 1983); Barry Barnes, *Scientific Knowledge and Sociological Theory* (London: Routledge & Kegan Paul, 1974); and idem, *Interests and the Growth of Knowledge* (London: Routledge and Kegan Paul, 1977). For a recent recension, see Barry Barnes, David Bloor, and John Henry, *Scientific Knowledge: A Sociological Analysis* (London: Athlone, 1996).

[26] Recent books are: John Law, *Aircraft Stories: Decentering the Object in Technoscience* (Durham, North Carolina: Duke University Press, 2002); and *After Method: Mess in Social Science Research* (London: Routledge, 2004).

[27] Brian Wynne, "Reflexing Complexity: Post-Genomic Knowledge and Reductionist Returns in Public Science", *Theory, Culture and Society*, 22 (2005); "Public Engagement as a Means of Restoring Public

Trust in Science—Hitting the Notes, but Missing the Music?", *Community Genetics*, 9 (2007), pp 211-220; "Risky Delusions: Misunderstanding Science and Misperforming Publics in the GE Crops Issue", in I. E. P. Taylor (ed.) *Genetically Engineered Crops: Interim Policies, Uncertain Legislation* (Binghamton, New York: Haworth Press, 2007).

[28] Andrew Pickering, *Constructing Quarks: A Sociological History of Particle Physics* (Edinburgh: Edinburgh University Press, 1984). More recently he has published, *The Mangle of Practice: Time, Agency, and Science* (Chicago: University of Chicago Press, 1995).

[29] The thesis was published as: Graham Spinardi, *From Polaris to Trident: The Development of US Fleet Ballistic Missile Technology* (Cambridge University Press, 1994). See also idem, "Prospects for the Defence Diversification Agency: Technology Transfer and the UK Defence Research Establishments", *Science and Public Policy*, 27 (2000); "Industrial Exploitation of Carbon Fibre in the UK, USA and Japan", *Technology Analysis and Strategic Management*, 14 (2002).

[30] Sample publications include: Matthias Klaes, "Sociotechnical Constituencies, Game Theory, and the Diffusion of Compact Discs: An Inter-Disciplinary Investigation into the Market for Recorded Music", *Research Policy*, 25 (1997), pp. 1221-34; S. Dow, M. Klaes and A. Montagnoli, "Monetary Policy by Signal", in D. G. Mayes and J. Toporowski (eds), *Open Market Operations and the Financial Markets* (London: Routledge, 2007); Matthias Klaes and Esther-Mirjam Sent, "A Conceptual History of the Emergence of Bounded Rationality", *History of Political Economy*, 37 (2005), pp. 27-60.

[31] See Massimo Mazzotti, "The Geometers of God: Mathematics and Reaction in the Kingdom of Naples", *Isis,* 87 (1998), pp. 678-701. He has more recently published, *The World of Maria Gaetana Agnesi, Mathematician of God* (Baltimore: Johns Hopkins University Press, 2007).

[32] Work undertaken in Edinburgh included: Martin Kusch, *Psychologism: A Case Study in the Sociology of Philosophical Knowledge* (London: Routledge, 1995); (with Harry M. Collins) *The Shape of Actions: What Humans and Machines Can Do* (Cambridge, Mass.: MIT Press, 1998); *Psychological Knowledge: A Social History and Philosophy* (London: Routledge, 1999).

[33] Donald A. MacKenzie, *Statistics in Britain, 1865-1930: The Social Construction of Scientific Knowledge* (Edinburgh: Edinburgh University Press, 1981). Examples of Professor MacKenzie's other books include: *Inventing Accuracy: An Historical Sociology of Nuclear Missile Guidance* (Cambridge, Mass.: MIT Press, 1990); *Knowing Machines: Essays on Technical Change* (Cambridge, Mass.: MIT Press, 1996); *Mechanizing Proof: Computing, Risk, and Trust* (Cambridge, Mass.: MIT Press, 2001);

An Engine, Not a Camera: How Financial Models Shape Markets (Cambridge, Mass.: MIT Press, 2006).

[34] See, for example, Wendy Faulkner, "Dualisms, Hierarchies and Gender in Engineering", *Social Studies of Science*, 30 (2000), pp. 759-92; "The Technology Question in Feminism: A View from Feminist Technology Studies", *Women's Studies International Forum*, 24 (2001), pp. 79-95; "'Nuts and bolts and people': Gender-Troubled Engineering Identities" *Social Studies of Science*, 37 (2007), pp. 331-356.

[35] R. Fincham, J. Fleck, R. Proctor, H. Scarbrough, M. Tierney and Robin Williams, *Expertise and Innovation: Information Technology Strategies in the Financial Services Sector* (Oxford: Clarendon Press, 1994); Herbert Kubicek, William H. Dutton, and Robin Williams (eds), *The Social Shaping of Information Superhighways: European and American Roads to the Information Society* (Frankfurt: Campus Verlag, 1997); Anthony Clayton, Graham Spinardi and Robin Williams, *Policies for Cleaner Technology: A New Approach for Government and Industry* (London: Earthscan, 1999); and Robin Williams, James Stewart, and Roger Slack, *Social Learning In Technological Innovation: Experimenting with Information and Communication Technologies* (Cheltenham: Edward Elgar, 2005).

[36] Professor Tait and Dr Lyall recently co-edited a volume reflecting the multi-disciplinary nature of Innogen's work: Catherine Lyall and Joyce Tait (eds), *New Modes of Governance: Developing an Integrated Policy Approach to Science, Technology, Risk and the Environment* (Aldershot: Ashgate, 2005). For sample publications by David Wield, consider N. Forbes and David Wield, *From Followers to Leaders: Innovation Management in Newly Industrialising Countries* (London: Routledge, 2002); J. Chataway, J. Tait, and D. Wield, "The Governance of Agro- and Pharmaceutical Biotechnology: public policy and firm strategy", *Technology Analysis and Strategic Management*, 18 (2006), pp. 169-185; and Ayele, S., Chataway, J. and Wield, D (2006) "Partnerships in African Crop Biotechnology and the Millenium Development Goals", *Nature Biotechnology*, 24 (2006), pp. 619-621.

[37] Recent books include: Stephen Yearley, *Making Sense of Science* (London: Sage, 2005); and *Cultures of Environmentalism* (Basingstoke: Palgrave Macmillan, 2005).

[38] Martin Fransman, *The Market and Beyond: Information Technology in Japan* (Cambridge: Cambridge University Press, 1993); *Japan's Computer and Communications Industry: The Evolution of Industrial Giants and Global Competitiveness* (Oxford : Oxford University Press, 1995); *Visions of*

Innovation: The Firm and Japan (Oxford : Oxford University Press, 1999); *Telecoms in the Internet Age: From Boom to Bust to—?* (Oxford : Oxford University Press, 2002).

[39] For a major study of the history of the Gifford Lectures, see Larry Witham, *The Measure of God: Our Century-Long Struggle to Reconcile Science & Religion* (San Francisco: Harper, 2005). There is also an excellent and highly informative website: http://www.giffordlectures.org

[40] Michael Fuller, *Atoms and Icons: A Discussion of the Relationships between Science and Theology* (London: Mowbray, 1995); "A Typology for the Theological Reception of Scientific Innovation", *Science and Christian Belief*, 12 (2000); and "Biotechnology and Ethics: A Locus for the Reintegration of Science and Wisdom?" in Hubert Meisinger, Willem B. Drees and Zbigniew Liana (eds.), *Wisdom or Knowledge? Science, Theology and Cultural Dynamics* (Edinburgh: T. & T. Clark, 2006).

[41] For sample publications in the area by each member of the team, consider: David Fergusson, *The Cosmos and the Creator: Introduction to the Theology of Creation* (London: SPCK, 1998); and *Scottish Philosophical Theology* (Exeter: Imprint Academic Press, 2007). John Henry, "Metaphysics and the Origins of Modern Science: Descartes and the Importance of Laws of Nature", *Early Science and Medicine*, 9 (2004), pp. 73-114; and "Psychology and the Laws of Nature: From Souls to the Powers of the Mind in the Scottish Enlightenment", in Andrew Cunningham and Ole Peter Grell (eds), *Medicine and Religion in Enlightenment Europe* (Aldershot: Ashgate Press, 2007), pp. 243-58. W. C. K. Poon, "'You must name him Jesus': Being Named as Kenosis", *Theology*, 103 (2000), pp. 433-436; and "History, Science and Theology: An Essay Review of Han Schwarz's *Creation*", *Theology*, 107 (2004), pp. 37-44. See previous note for examples of Michael Fuller's publications.

[42] Michael S. Northcott, *A Moral Climate: The Ethics of Global Warming* (London: Darton, Longman and Todd Ltd, 2007). See also idem, *The Environment and Christian Ethics* (Cambridge: Cambridge University Press, 1996).